Vermont-PASS Assessment Blueprint

The Partnership for the Assessment of Standards-based Science (PASS) is a collaboration of states, regions and school districts engaged in science education reform. PASS was established in 1996 with funding provided by the National Science Foundation. Its purpose is to assist schools, districts, and states with the development, administration, scoring, and reporting of valid and reliable standards-based science assessments that match the learning goals of the National Science Education Standards (1996).

After an extensive review of the National PASS program, including alignment studies between the *Vermont Framework of Standards and Learning Opportunities* (hereinafter referred to as the Vermont Framework), the National Science Education Standards, and the PASS science assessment, Vermont joined the partnership in the fall of 2000. PASS and the Vermont customized version of the assessment, "Vermont-PASS," measures the extent to which students are achieving science literacy as defined by the National Science Education Standards and the Vermont Framework. As participating members of the PASS assessment development process, Vermont teachers and scientists will work to ensure that the assessment represents what Vermont values for the science education of all our students.

The Vermont-PASS Assessment Blueprint was developed to help educators understand the Vermont-PASS assessment and to maximize its use in making local science curriculum, instruction, and professional development decisions. The Blueprint will guide teachers as they reflect on science content, assessment, and practice. It will also guide action-planning committees as they use the assessment data to inform their decisions.

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The Partnership for the Assessment of Standards-based Science uses the National Science Education Standards (1996) as the criteria in developing the assessment. An alignment study conducted by Vermont Institutes (VI) and West Ed. in the fall of 1999 concluded that there is a very close correlation between the National Science Standards and the Vermont Framework Science Standards. In addition, Vermont's participation in the development of future forms of the PASS assessment will guarantee that the test will continue to measure the scientific skills and understandings that we value for Vermont students. In order to understand and make use of the alignment between the Vermont Framework, the National Science Education Standards, and the Vermont-PASS assessment, an assessment domain has been developed.

The domain for the fifth grade assessment includes the content of the K-4 cluster within the Vermont Framework and the National Science Standards. The ninth grade test includes the content of the K-8 cluster and the eleventh grade assessment includes the content of the K-8 cluster and the developmentally appropriate content from the 9-12 Standards. Many of the concepts associated with Vermont's Vital Results (1.17, 3.9), Systems Standards (7.11), and Technology Standards (7.16, 7.17, 7.18) are embedded in the content of the National Science Standards and Vermont-PASS. However, the Vital Results, Systems Standards, and Technology Standards will not be reported independently on Vermont-PASS. Therefore, they will not appear independently as a field of knowledge within the Vermont-PASS domain.

How to use the Vermont-PASS Assessment Domain
The Vermont-PASS assessment domain serves three important functions:

- For teachers and students, it describes the skills and understandings that are "fair game" on the Vermont-PASS assessment.

- School reports for Vermont-PASS will provide information regarding the percentage of students who would benefit from additional opportunities to learn the skills and concepts included in the Vermont-PASS domain. (See "Score Reports")

- For those involved in science action planning at the local level, the domain and accompanying information from the National Science Standards will provide a valuable resource in helping to guide the implementation of the Vermont Framework. In addition to the science content standards, the National Science Education Standards contain valuable information regarding teaching, professional development, assessment, and support related to science education (to order call: 1-800-624-6242)

The graphic on the next page explains the coding and format used in the domain.

Coding and Format Used in the Domain

Identifies the broad content of the standard and references the page number from the National Science Education Standards on which the content can be found. This is the level of reporting for the Content Recommendations. (See Score Reports)

Identifies the science content area of the standard.

Identifies the fundamental ideas that underlie the standard. In this example, PS1.1 refers to Physical Science, concept 1, fundamental idea 1. On page 127 of the National Science Standards, the reader will fnd that the fundamental ideas are highlighted with brown bullets rather than a numerical code. This is consistent throughout the document.

Identifies the Standard and Evidence from the Vermont Framework.

Physical Science	VT-Framework
Properties of Objects and Materials NSES: p. 127	
• PS 1.1 Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers.	7.12 a.
• PS 1.2 Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.	7.12 a.
• PS 1.3 Materials can exist in different states-solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling.	7.12 b.
Position and Motion of Objects NSES: p. 127	
• PS 2.1 The position of an object can be described by locating it relative to another object or the background.	7.12 d.
• PS 2.2 An object's motion can be described by tracing and measuring its position over time.	7.12 d.
• PS 2.3 The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.	7.12 d.
• PS 2.4 Sound is produced by vibrating objects.	7.12 e.
Light, Heat, Electricity, and Magnetism NSES: p. 127	
• PS 3.1 Light travels in a straight line until it strikes an object. Light can be reflected, refracted. or absorbed.	7.12 e.
• PS 3.2 Heat can be produced in many ways, such as burning or rubbing. Heat can move from one object to another.	7.12 e.
• PS 3.3 Electricity can produce light, heat, sound, and magnetic effects. Electric circuits require a complete loop through which an electrical current can pass.	7.12 f.
• PS 3.4 Magnets attract and repel each other and certain kinds of other materials.	7.12 f.

Additional Coding Used in the Vermont-PASS Assessment Domain

NSES = National Science Education Standards
SI = Science as Inquiry PS = Physical Science ES = Earth and Space Science LS = Life Science
UCP = Unifying Concepts and Practices SPSP = Science in Personal and Social Perspectives
HNS = History and Nature of Science

Domain of the Vermont-PASS Science Assessment
Grade 5

Science as Inquiry	VT-Framework
Abilities Necessary to do Scientific Inquiry NSES: p. 122	
• SI 1.1 Ask a question about objects, organisms, and events in the environment • SI 1.2 Plan and conduct a simple investigation. • SI 1.3 Employ simple equipment and tools to gather data and extend the senses. • SI 1.4 Use data to construct a reasonable explanation. • SI 1.5 Communicate investigations and explanations	7.1 a. 7.2 a. 7.1 c. 7.1 c., 7.1 d. 1.17 a.b.c.d.
Understanding About Scientific Inquiry NSES: p. 123	
• SI 2.1 Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world • SI 2.2 Scientists use different kinds of investigations depending on the questions they are trying to answer. Types of investigations include describing objects, events, and organisms; classifying them; and doing a fair test (experimenting). • SI 2.3 Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses. • SI 2.4 Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.	7.1 a. 7.1 c. 7.3 a.
Science and Technology in Local Challenges NSES: p. 141 (SPSP 4.2)	7.5 a.
Evidence, Models, and Explanations NSES: p. 117 (UCP 2.0)	1.17 a.b.c.d.

Physical Science	VT-Framework
Properties of Objects and Materials NSES: p. 127	
• PS 1.1 Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers. • PS 1.2 Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials. • PS 1.3 Materials can exist in different states-solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling.	7.12 a. 7.12 a. 7.12 b.
Position and Motion of Objects NSES: p. 127	
• PS 2.1 The position of an object can be described by locating it relative to another object or the background. • PS 2.2 An object's motion can be described by tracing and measuring its position over time. • PS 2.3 The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull. • PS 2.4 Sound is produced by vibrating objects.	7.12 d. 7.12 d. 7.12 d. 7.12 e.
Light, Heat, Electricity, and Magnetism NSES: p. 127	
• PS 3.1 Light travels in a straight line until it strikes an object. Light can be reflected, refracted. or absorbed. • PS 3.2 Heat can be produced in many ways, such as burning or rubbing. Heat can move from one object to another. • PS 3.3 Electricity can produce light, heat, sound, and magnetic effects. Electric circuits require a complete loop through which an electrical current can pass. • PS 3.4 Magnets attract and repel each other and certain kinds of other materials.	7.12 e. 7.12 e. 7.12 f. 7.12 f.

Earth and Space Science	VT-Framework
Properties of Earth Materials NSES: p. 134	
• ES 1.1 Earth materials are solid rocks and soils, water, and the gases of the atmosphere. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel, or for growing the plants we use as food. Earth materials provide many of the resources that humans use.	7.15 e.
• ES 1.2 Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants, including those in our food supply.	7.15 e.
• ES 1.3 Fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.	7.15 a.
Objects in the Sky NSES: p. 134	
• ES 2.1 The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described. • ES 2.2 The sun provides the light and heat necessary to maintain the temperature of the earth.	7.15 c.
Changes in Earth and Sky NSES: p. 134	
• ES 3.1 The surface of the earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.	7.15 a.
• ES 3.2 Weather changes from day to day and over the seasons. Weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation.	7.15 b.
• ES 3.3 Objects in the sky have patterns of movement. The sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. The moon moves across the sky a daily basis much like the sun. The observable shape of the moon changes from day to day in a cycle that lasts about a month.	7.15 d.

Life Science	VT Framework
The Characteristics of Organisms: NSES p. 129	
• LS 1.1 Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light. Organisms can survive only in environments in which their needs can be met. The world has many different environments, and distinct environments support the life of different types of organisms. • LS 1.2 Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking. • LS 1.3 The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as a change in the environment). Humans and other organisms have senses that help them detect internal and external cues.	7.13 a. 7.13 a. 7.13 a.
Life Cycles of Organisms NSES: p. 129	
• LS 2.1 Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying. The details of this life cycle are different for different organisms. • LS 2.2 Plants and animals closely resemble their parents. • LS 2.3 Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interactions with the environment. Inherited characteristics include the color of flowers and the number of limbs of an animal. Other features, such as the ability to ride a bicycle, are learned through interactions with the environment and cannot be passed on to the next generation.	7.13 c. 7.14 a. 7.14 a.
Organisms and Environments NSES: p. 129	
• LS 3.1 All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants. • LS 3.2 An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment. When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations • LS 3.3 All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial. • LS 3.4 Humans depend on their natural and constructed environments. Humans change environments in ways that can be either beneficial or detrimental for themselves and other organisms.	7.13 c. 7.13 c., 3.9 d. 7.13 c. 7.15 e., 3.9 c.

Domain of the Vermont-PASS Science Assessment
Grade 9

Science as Inquiry	VT-Framework
Abilities Necessary to do Scientific Inquiry NSES: p. 145	
• SI 1.1 Identify questions that can be answered through scientific investigations. • SI 1.2 Design and conduct a scientific investigation. • SI 1.3 Use appropriate tools and techniques to gather, analyze, and interpret data. • SI 1.4 Develop descriptions, explanations, predictions, and models using evidence. • SI 1.5 Think critically and logically to make the relationships between evidence and explanations. • SI 1.6 Recognize and analyze alternative explanations and predictions. • SI 1.7 Communicate scientific procedures and explanations. • SI 1.8 Use mathematics in all aspects of scientific inquiry.	7.1 aa. 7.1 cc. 1.17 aa. 7.1 dd. 7.1 cc. 7.1 gg. 1.17 bb. 1.17 aa.
Understandings About Scientific Inquiry NSES: p. 148	
• SI 2.1 Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models. • SI 2.2 Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding. • SI 2.3 Mathematics is important in all aspects of scientific inquiry. • SI 2.4. Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations. • SI 2.5 Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances. • SI 2.6 Science advances through legitimate skepticism. Asking questions and querying other scientists' explanations is part of scientific inquiry. Scientists evaluate the explanations proposed by other scientists by examining evidence, comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. • SI 2.7 Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.	7.3 cc. 7.3 aa 7.3 bb. 7.3 cc. 7.3 bb. 7.3 cc.
Science and Technology in Society NSES: p. 169 (SPSP 5.6) **Natural Hazards NSES: p. 168 (SPSP 3.1)**	7.5 aa.

Physical Inquiry	VT-Framework
Properties and Changes of Properties in Matter NSES: p. 154	
• PS 1.1 A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties. • PS 1.2 Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved. Substances often are placed in categories or groups if they react in similar ways; metals is an example of such a group. • PS 1.3 Chemical elements do not break down during normal laboratory reactions involving such treatments as heating, exposure to electric current, or reaction with acids. There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances that we encounter.	7.12 aa. 7.12 bb. 7.12 bb.
Motions and Forces NSES: p. 154	
• PS 2.1 The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph. • PS 2.2 An object that is not being subjected to a force will continue to move at a constant speed and in a straight line. • PS 2.3 If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.	7.12 dd. 7.12 dd. 7.12 dd.
Transfer of Energy NSES: p. 155	
• PS 3.1 Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. • PS 3.2 Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature. • PS 3.3 Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object--emitted by or scattered from it--must enter the eye. • PS 3.4 Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced. • PS 3.5 In most chemical and nuclear reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers. • PS 3.6 The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.	7.12 ee. 7.12 ee. 7.12 ee. 7.12 ee. 7.12 bb. 7.12 ee.

Earth and Space Science	VT-Framework
Structure of the Earth System NSES: pp. 159, 160	
• ES 1.1 The solid earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core.	
• ES 1.2 Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.	7.15 bb.
• ES 1.3 Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.	7.15 cc.
• ES 1.4 Some changes in the solid earth can be described as the "rock cycle." Old rocks at the earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rock. Eventually, those new rocks may be brought to the surface by the forces that drive plate motions, and the rock cycle continues.	7.15 bb.
• ES 1.6 Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.	7.15 cc.
• ES 1.8 The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.	7.15 cc.
• ES 1.9 Clouds, formed by the condensation of water vapor, affect weather and climate.	7.15 cc.
• ES 1.91 Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.	7.15 cc.
Earth's History NSES: p. 160	
• ES 2.1. The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.	7.15 aa.
• ES 2.2 Fossils provide important evidence of how life and environmental conditions have changed.	7.15 aa.
Earth in the Solar System NSES: pp. 160, 161	
• ES 3.1 The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The sun, an average star, is the central and largest body in the solar system.	7.15 dd.
• ES 3.2 Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.	7.15 dd.
• ES 3.3 Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system. Gravity alone holds us to the earth's surface and explains the phenomena of the tides.	7.15 dd.
• ES 3.4 The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day.	7.15 dd.

Life Science	VT-Framework
Structure and Function in Living Systems NSES: p. 156	
• LS 1.1 Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms, and ecosystems	7.13 aa.
• LS 1.2 All organisms are composed of cells--the fundamental unit of life. Most organisms are single cells; other organisms, including humans, are multicellular.	7.13 aa.
• LS 1.3 Cells carry on the many functions needed to sustain life. They grow and divide, thereby producing more cells. This requires that they take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs.	7.13 aa.
• LS 1.4 Specialized cells perform specialized functions in multicellular organisms. Groups of specialized cells cooperate to form a tissue, such as a muscle. Different tissues are in turn grouped together to form larger functional units, called organs. Each type of cell, tissue, and organ has a distinct structure and set of functions that serve the organism as a whole.	7.13 aa.
• LS 1.5 The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control, and coordination, and for protection from disease. These systems interact with one another.	7.13 aa.
• LS 1.6 Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms.	7.14 cc.
Reproduction and Heredity NSES: p. 157	
• LS 2.1 Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually.	7.13 aa. 7.14 dd.
• LS 2.2 In many species, including humans, females produce eggs and males produce sperm. Plants also reproduce sexually--the egg and sperm are produced in the flowers of flowering plants. An egg and sperm unite to begin development of a new individual. That new individual receives genetic information from its mother (via the egg) and its father (via the sperm). Sexually produced offspring never are identical to either of their parents.	7.14 dd. 7.13 aa.
• LS 2.3 Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.	7.14 aa.
• LS 2.4 Hereditary information is contained in genes, located in the chromosomes of each cell. Each gene carries a single unit of information. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes.	7.13 aa. 7.14 aa.
• LS 2.5 The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment.	7.13 dd. 7.14.aa.

Life Science (Continued)	VT-Framework
Regulation and Behavior NSES: p. 157	
• LS 3.1 All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.	7.13 aa.
• LS 3.2 Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive.	7.14 bb.
• LS 3.3 Behavior is one kind of response an organism can make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels, including cells, organ systems, and whole organisms. Behavioral response is a set of actions determined in part by heredity and in part from experience.	7.13 aa.
• LS 3.4 An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.	7.13 dd.
Populations and Ecosystems NSES: p. 157	
• LS 4.1 A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.	7.13 c.
• LS 4.2 Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some micro-organisms are producers. They make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.	7.13 cc.
• LS 4.3 For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.	
• LS 4.4 The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.	7.13 cc.
Diversity and Adaptations of Organisms NSES: p. 158	
• LS 5.1 Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry.	7.13 dd.
• LS 5.2 Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.	7.13 dd.
• LS 5.3 Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.	7.13 dd.

Domain of the Vermont-PASS Science Assessment
Grade 11

Science as Inquiry	VT-Framework
Abilities Necessary to do Scientific Inquiry NSES: p. 1175	
• SI 1.1 Identify questions and concepts that guide scientific investigation. • SI 1.2 Design and conduct a scientific investigation. • SI 1.3 Use technology and mathematics to improve investigations and communications. • SI 1.4 Formulate and revise scientific explanations and models using logic and evidence. • SI 1.5 Recognize and analyze alternative explanations and models. • SI 1.6 Communicate and defend a scientific argument.	7.1 aaa. 7.2 aa. 1.21 7.1 ddd. 7.1ggg. 3.7 cc.
Understandings About Scientific Inquiry NSES: p. 148	
• SI 2.1 Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists. • SI 2.2 Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories. • SI 2.3 Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used. • SI 2.4 Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results. • SI 2.5 Scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide by the rules of evidence; it must be open to questions and possible modification; and it must be based on historical and current scientific knowledge. • SI 2.6 Results of scientific inquiry--new knowledge and methods--emerge from different types of investigations and public communication among scientists. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge. In addition, the methods and procedures that scientists used to obtain evidence must be clearly reported to enhance opportunities for further investigation.	7.3 aaa. 7.1 bbb. 7.1 ddd.
Population Growth NSES: p. 198 (SPSP 2.3) **Science and Technology in Local, National, and Global Challenges NSES: p. 199 (SPSP 5.2)** **Science as a Human Endeavor NSES: p. 200 (HNS 1.2)** **Nature of Scientific Knowledge NSES: p. 201 (HNS 2.2)**	3.9 dd. 7.5 aaa. 7.13 aaa.

Physical Science	VT-Framework
Structure of Atoms NSES: p. 178	
• PS 1.1 Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atom together. • PS 1.2 The atom's nucleus is composed of protons and neutrons, which are much more massive than electrons. When an element has atoms that differ in the number of neutrons, these atoms are called different isotopes of the element.	7.12 bbb. 7.12 bbb.
Structure and Properties of Matter NSES: p. 178	
• PS 2.1 Atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus. These outer electrons govern the chemical properties of the element. • PS 2.2 An element is composed of a single type of atom. When elements are listed in order according to the number of protons (called the atomic number), repeating patterns of physical and chemical properties identify families of elements with similar properties. This "Periodic Table" is a consequence of the repeating pattern of outermost electrons and their permitted energies. • PS 2.3 Bonds between atoms are created when electrons are paired up by being transferred or shared. A substance composed of a single kind of atom is called an element. The atoms may be bonded together into molecules or crystalline solids. A compound is formed when two or more kinds of atoms bind together chemically. • PS 2.4 The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them. • PS 2.5 Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.	7.12 aaa. 7.12 bbb. 7.12 bbb. 7.12 aaa. 7.12 bbb.
Chemical Reactions: p. 179	
• PS 3.2 Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog. • PS 3.3 A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms. In other reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds. Radical reactions control many processes such as the presence of ozone and greenhouse gases in the atmosphere, burning and processing of fossil fuels, the formation of polymers, and explosions. • PS 3.5 Catalysts, such as metal surfaces, accelerate chemical reactions. Chemical reactions in living systems are catalyzed by protein molecules called enzymes.	7.12 eee. 7.12 aaa. 7.12 aaa

Physical Science (Continued)	VT-Framework
Motions and Forces NSES: p. 179, 180	
• PS 4.1 Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship F = ma, which is independent of the nature of the force. • PS 4.2 Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object. • PS 4.3 Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely to the square of the distance between them. • PS 4.4 Between any two charged particles, electric force is vastly greater than the gravitational force. Most observable forces such as those exerted by a coiled spring or friction may be traced to electric forces acting between atoms and molecules. • PS 4.5 Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.	7.12 ddd. 7.12 ddd. 7.12 ddd. 7.12 eee. 7.12 fff.
Conservation of Energy and the Increase in Disorder NSES: p. 180	
• PS 5.1 The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed. As these transfers occur, the matter involved becomes steadily less ordered. • PS 5.2 All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves. • PS 5.3 Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion. • PS 5.4 Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction, radiation, or convection and the warming of our surroundings when we burn fuels.	7.12 eee. 7.12 eee. 7.12 eee. 7.12 eee.
Interactions of Energy and Matter NSES: p. 180	
• PS 6.1 Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter. • PS 6.2 Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength. • PS 6.3 Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance. • PS 6.4 In some materials, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior. At low temperatures some materials become superconductors and offer no resistance to the flow of electrons.	7.12 eee. 7.12 fff. 7.12 eee. 7.12 ee.

Earth and Space Science	VT-Framework
Energy in the Earth System NSES: p. 189	
• ES 1.1 Earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the earth's original formation. • ES 1.2 The outward transfer of earth's internal heat drives convection circulation in the mantle that propels the plates comprising earth's surface across the face of the globe. • ES 1.3 Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. • ES 1.4 Global climate is determined by energy transfer from the sun at and near the earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the earth's rotation, and static conditions such as the position of mountain ranges and oceans.	7.15 ccc. 7.15 ccc. 7.15 ccc. 7.15 bbb
Geochemical Cycles NSES: p. 189	
• ES 2.1 The earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on earth moves among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles. • ES 2.2 Movement of matter between reservoirs is driven by the earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.	7.15 ccc. 7.15 ccc.
The Origin and Evolution of the Earth System NSES: p. 189	
• ES 3.1 The sun, the earth, and the rest of the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. The early earth was very different from the planet we live on today. • ES 3.2 Geologic time can be estimated by observing rock sequences and using fossils to correlate the sequences at various locations. Current methods include using the known decay rates of radioactive isotopes present in rocks to measure the time since the rock was formed. • ES 3.3 Interactions among the solid earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the earth system. We can observe some changes such as earthquakes and volcanic eruptions on a human time scale, but many processes such as mountain building and plate movements take place over hundreds of millions of years. • ES 3.4 Evidence for one-celled forms of life--the bacteria--extends back more than 3.5 billion years. The evolution of life caused dramatic changes in the composition of the earth's atmosphere, which did not originally contain oxygen.	7.15 ff 7.15 aaa. 7.15 bbb. 7.15 aaa.

Earth and Space Science (Continued)	VT-Framework
The Origin and Evolution of the Universe NSES: p. 190	
• ES 4.1 The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state; according to this theory, the universe has been expanding ever since. • ES 4.2 Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars. Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe. • ES 4.3 Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.	7.15 ff. 7.15ddd. 7.15 ddd.

Life Science	VT-Framework
The Cell NSES: p. 184	
• LS 1.1 Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules which form a variety of specialized structures that carry out such cell functions as energy production, transport of molecules, waste disposal, synthesis of new molecules, and the storage of genetic material. • LS 1.2 Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by a large set of protein catalysts, called enzymes. The breakdown of some of the food molecules enables the cell to store energy in specific chemicals that are used to carry out the many functions of the cell. • LS 1.3 Cells store and use information to guide their functions. The genetic information stored in DNA is used to direct the synthesis of the thousands of proteins that each cell requires. • LS 1.4. Cell functions are regulated. Regulation occurs both through changes in the activity of the functions performed by proteins and through the selective expression of individual genes. This regulation allows cells to respond to their environment and to control and coordinate cell growth and division. • LS 1.5 Plant cells contain chloroplasts, the site of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment. This process of photosynthesis provides a vital connection between the sun and the energy needs of living systems. • LS 1.6 Cells can differentiate, and complex multicellular organisms are formed as a highly organized arrangement of differentiated cells. In the development of these multicellular organisms, the progeny from a single cell form an embryo in which the cells multiply and differentiate to form the many specialized cells, tissues and organs that comprise the final organism. This differentiation is regulated through the expression of different genes.	7.13 aaa. 7.13 aaa. 7.13 aaa. 7.13 aaa. 7.13 aaa.
The Molecular Basis of Heredity NSES: p. 185	
• LS 2.1 In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular "letters") and replicated (by a templating mechanism). Each DNA molecule in a cell forms a single chromosome. • LS 2.2 Most of the cells in a human contain two copies of each of 22 different chromosomes. In addition, there is a pair of chromosomes that determines sex: a female contains two X chromosomes and a male contains one X and one Y chromosome. Transmission of genetic information to offspring occurs through egg and sperm cells that contain only one representative from each chromosome pair. An egg and a sperm unite to form a new individual. The fact that the human body is formed from cells that contain two copies of each chromosome--and therefore two copies of each gene--explains many features of human heredity, such as how variations that are hidden in one generation can be expressed in the next. • LS 2.3 Changes in DNA (mutations) occur spontaneously at low rates. Some of these changes make no difference to the organism, whereas others can change cells and organisms. Only mutations in germ cells can create the variation that changes an organism's offspring.	7.13 aaa 7.14 aaa. 7.14 aaa.

Life Science (Continued)	VT-Framework
Biological Evolution NSES: p. 185	
• LS 3.1 Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.	7.13 ddd.
• LS 3.2 The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.	7.13 ddd.
• LS 3.3 Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as for the striking molecular similarities observed among the diverse species of living organisms.	7.13 ddd.
• LS 3.4 The millions of different species of plants, animals, and microorganisms that live on earth today are related by descent from common ancestors.	7.13 ddd.
• LS 3.5 Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities which reflect their evolutionary relationships. Species is the most fundamental unit of classification.	7.13 bbb.
The Interdependence of Organisms NSES: p. 186	
• LS 4.1The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.	7.13 ccc.
• LS 4.2 Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.	7.13 ccc.
• LS 4.3 Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.	7.13 ccc.
• LS 4.4 Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.	7.13 ccc.
• LS 4.5 Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.	3.9 dd.

Life Science (Continued)	VT-Framework
Matter, Energy, and Organization In Living Systems NSES: p. 186	
• LS 5.2 The energy for life primarily derives from the sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. These molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars, and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes. • LS 5.3 The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells usually store this energy temporarily in phosphate bonds of a small high-energy compound called ATP. • LS 5.4 The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism. • LS 5.5 The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials. • LS 5.6 As matter and energy flows through different levels of organization of living systems--cells, organs, organisms, communities--and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.	7.13 ccc. 7.13 aaa. 7.13 ccc. 7.13 ccc. 7.13 ccc.
The Behavior of Organisms NSES: p. 187	
• LS 6.2 Organisms have behavioral responses to internal changes and to external stimuli. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.	7.13 ccc.

Vermont-PASS Practice Tests

The appendix of this document contains practice tests of the Vermont-PASS science assessment at all three grade levels (5, 9 and 11). Each test contains a reproducible student version followed by a teacher version. The teacher version contains scoring guides, standards alignment, suggestions related to materials, and additional science content information. The table below describes the three components of the Vermont-PASS assessment that are also included in the practice tests.

Component	Description	Purpose
Multiple-choice Questions	The practice tests contain four multiple choice questions at each level. They were chosen to round out the science content of the sample tests and to serve as representative samples of this type of item. The actual test will contain 40 multiple choice items, divided into two sessions.	These questions assess Students' understanding of a broad range of concepts included in the Vermont Framework Science Standards and the National Science Education Standards.
Open-ended or Constructed Response Items	Students are presented with a question or problem and construct their own answer by writing a short paragraph, drawing a diagram, and/or manipulating data. The practice tests contain two open-ended items at each level. Each student will also complete two open-ended items on the actual test. These items most closely resemble the constructed response items on the former VT Science Assessment.	These questions explore students' ability to communicate scientific information, reason scientifically, conduct secondary data analysis, design investigations, construct questions, and recommend solutions.
Hands-on Performance Tasks	Hands-on performance tasks provide students the opportunity to construct and validate ideas of science through inquiry and investigation. The practice tests contain one performance task at each level. The actual test will also contain one performance task at each level.	These tasks are developed using the Vermont-PASS Template contained in this document. Students are asked: • To replicate an experiment. • To collect and organize data and information. • To use scientific equipment and materials. • To use evidence to support or refute a prediction. • To demonstrate understanding of scientific concepts resulting from the experiment. • To use data/observations to apply, generalize or ask other questions based upon findings within a context.

How to Use the Vermont-PASS (Practice Tests)

These sample tests can be used to familiarize students with Vermont-PASS. They can also be used in conjunction with the Vermont-PASS Performance Task Template as a model for designing school and classroom science assessments. The following page contains pieces of student work from the 9th grade practice test "Scuba Divers." The student work has been scored and analyzed as an example of how a teacher might use this type of assessment to identify levels of performance and areas of need.

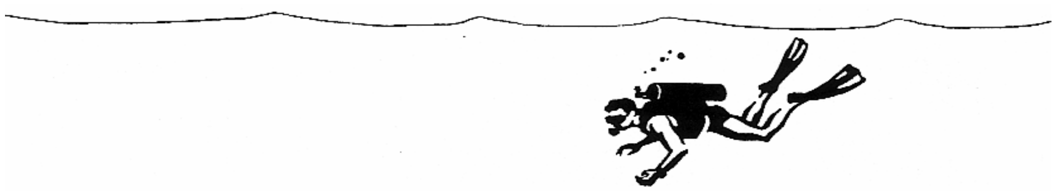
NOTE: View practice tests for Grade 5, Grade 9 and Grade 11

"Scuba Divers" Grade 9

Vermont Framework: Inquiry 7.1 cc. Create hypotheses to problems

NSES: SI 1.4 Develop descriptions, explanations, predicitions and models using evidence

Two identical twins named Jill and Rachel were planning separate trips to go scuba diving. Jill planned to scuba dive in the ocean off the coast of Main and Rachel planned to scuba dive in Lake Champlain.



Scuba divers who dive in cold water locations such as the ones the girls had chosen must wear wet suits. Wet suits make you more buoyant (cause you float). I order to sink, divers add lead bars to their belts. Jill and Rachel are the same size and the same weight, however, they were told that they would need to add different amounts of lead to their belts because one planned to dive in the ocean and the other planned to dive in a lake. The girls were curious about this and wondered if the different "sink weights" had something to do with their density compared to the density of the ocean and the lake. They decided to investigate density in order to help them understand this confusing situation. Their investigation question was "How doe the density on an object compare to the density of the liquid in which it is submerged?"

1. Using the experience of Jill and Rachel and your understanding of density, predict (formulate a hypothesis) about how the density of an object must compare to the density of a liquid in order for the object to sink in the liquid. Explain your thinking.

I think that the density of the object must be higher/greater than the density of the liquid in which they are submerged

Response #1

This response does not include either of the key elements. The student identified the cause (object with greater density than the liquid), but di not identify the effect (object sinks or floats) or state a rational.

2. Using the experience of Jill and Rachel and your understanding of density, predict (formulate a hypothesis) about how the density of an object must compare to the density of a liquid in order for the object to sink in the liquid. Explain your thinking.

I think for an object to sink in liquid it has to be more dinse than the liquid. If the object is more dense than the particles are closer together, therefore it makes it heavier and it sinks.

Response #2

This response includes both key elements. The student identifies a cause (object more dense than the liquid) and an effect (for an object to sink). The student also gives an explanation of his or her thinking.

Note: A student would receive points for both key elements even if their reasoning is flawed.

Scoring Guide - Key elements:

1. Hypothesis includes cause (density of an object, liquid or both) and effect (object sinks or does not sink in the liquid)
2. Hypothesis states a rational based on evidence from the scenario or prior knowledge.

Score Reports for the Vermont-PASS Assessment

This assessment is designed to provide school-wide data on science programs and individual student performance according to the recommendations of the Vermont Framework of Standards and Learning Opportunities and the National Science Education Standards. Although the assessment is being administered at grades 5, 9, and 11, it does not assess curricula exclusively at those grades but rather the students' accumulated knowledge and understanding of science. The items selected for inclusion sample the domain of science in elementary, middle, and secondary programs according to the Vermont Framework and the National Science Standards (see Vermont-PASS Domain). As it samples the field of Vermont science standards, this test will assess student understanding of those standards and will not evaluate the sum total of every student's scientific knowledge. By combining data from the Vermont-PASS assessment with feedback from local science assessments, schools can produce accurate and informative program and student profiles for science. Action planning teams at the school level will be able to use the results of Vermont-PASS as baseline and trend data, monitoring progress and growth over time as decisions are made regarding science curriculum, instruction, and professional development. The following information will be available for analysis:

- **Total Science scores reported according to the following performance levels:** achieved the standards with honors, achieved the standard, nearly achieved the standard, below the standard, and little or no evidence (see description of performance levels).
- **Scale scores for total science and the four content areas of the assessment domain** (inquiry, physical science, earth and space science, and life science). Scale scores combine the three test components (multiple choice, open-ended, and performance task) into one single score using a Rasch item response model.
- **Average Percent of Score Points Correct according to the types of items.** These results will enable schools to disaggregate student performance according to the three components of the test. In addition to the description and purpose of the three components (found in the Sample Test section of this document) schools will be provided with specific content information associated with the open-ended questions and the performance task reflected in the data.
- **Content Recommendations will be made according to the content standards (see Vermont-PASS Domain) from The National Science Education Standards and the Vermont Framework.** For example: At the fifth grade level, the first life science content standard deals with "The Characteristics of Organisms." A school might receive feedback stating {60% of the students who took the assessment would benefit from opportunities to explore the concepts related to The Characteristics of Organisms.} Schools would then be directed to refer to the Vermont-PASS Domain (Blueprint p. 7), the Vermont Framework (7.13), and the National Science Standards (pp. 127-129) for additional information regarding these concepts. For diagnostic purposes, schools will be directed to review the complete set of performance indicators related to a content standard that is reported. Technical assistance in regards to action planning and professional development will guide schools in this process.

Opportunity to Learn Data

In addition to score report data, schools will also receive feedback from students regarding the type of science they are learning, how they are learning it, and attitudes regarding science. Teacher survey data will include information regarding professional preparation to teach science, pedagogy, and opportunities for continued professional development. This opportunity to learn data can be used in conjunction with score report data to inform action planning.

Performance Level Descriptions for Vermont-PASS Science Assessment

Fifth Grade:

- **Achieved the standard with honors:** Student responses consistently demonstrate a clear understanding of concepts and skills associated with the K-4 science standards and evidence from the Vermont Framework. In addition, students should demonstrate a consistent ability to apply their understanding of these concepts and skills through the clear articulation of their scientific reasoning and the use of the inquiry process to construct and validate ideas of science.
- **Achieved the standard:** Student responses should substantially demonstrate a clear understanding of concepts and skills associated with the K-4 science standards and evidence from the Vermont Framework. In addition, the students should demonstrate a substantial ability to apply their understanding of these concepts and skills through the clear articulation of their scientific reasoning and the use of the inquiry process to construct and validate ideas of science.
- **Nearly achieved the standard:** Student responses should demonstrate a growing body of concepts and skills associated with the K-4 science standards and evidence from the Vermont Framework. In addition, the students should demonstrate a growing ability to apply their understanding of these concepts and skills through the articulation of their scientific reasoning and the use of the inquiry process to construct and validate ideas of science.
- **Below the standard:** Student responses should demonstrate a beginning/minimal understanding of concepts and skills associated with the K-4 science standards and evidence from the Vermont Framework. In addition, the students should demonstrate a beginning/minimal ability to apply their understanding of these concepts and skills through the articulation of their scientific reasoning and the use of the inquiry process to construct and validate ideas of science.
- **Little or no evidence:** Almost no attempt to respond or to demonstrate an understanding of concepts and skills associated with the K-4 science standards and evidence from the Vermont Framework.

Ninth Grade:

Using the same level descriptions as Grade 5 and including:

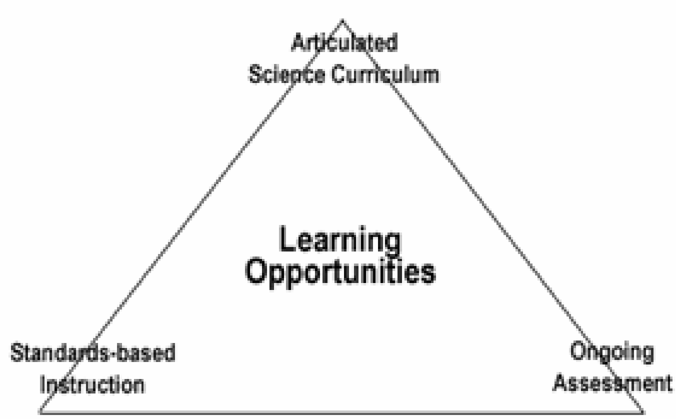
- Concepts and skills associated with the K-8 science standards and evidence from the Vermont Framework.

Eleventh Grade:

Using the same level descriptions as Grade 5 and including:

- Concepts and skills associated with the K-8 science standards and the developmentally appropriate content from the 9-12 science standards and evidence from the Vermont Framework.

As schools analyze and interpret the results of the Vermont-PASS Science Assessment, it is important to remember that research on best practice leads us to incorporate the Learning Opportunities of the Vermont Framework into a well thought out program of science study that progresses from K-12, that aligns with the Framework and the National Science Standards, and builds a solid base of knowledge and experience through the integration of the following:



How to Use Score Reports and Opportunity to Learn Data

The following vignette describes how a school-based team might use the Vermont-PASS score reports and opportunity to learn data to direct science action planning.

Green Mountain Elementary School received the following results after administering the Vermont - PASS assessment to all of their fifth grade students.

Vermont-PASS Score Results:
- Although a large number of students are in the "achieved the standards" or "honors" categories, a significant percentage is still performing at the nearly achieved, below, or little evidence levels.
- Scale scores indicated that fewer students responded correctly to questions dealing with physical science concepts compared to questions that assessed the other content areas. Scale scores for Inquiry were also slightly lower.
- Type of Item data indicated that students did not perform as well on the performance task investigation as they did on the other two components of the assessment.
- The highest percentages of students recommended for additional opportunities to explore concepts fell in the following areas:
  - Abilities necessary to do scientific inquiry [VT-Framework 7.1, 7.2, 1.17; NSES p.122]
  - Properties of Objects and Materials [VT-Framework 7.12(a)(b); NSES p.127]
  - Position and Motion of Objects [VT-Framework 7.12(d)(e); NSES p.127]
  - Light, Heat, Electricity, and Magnetism [VT-Framework 7.12(e)(f); NSES p.127]
  - Properties of earth materials [VT-Framework 7.15(a)(e); NSES p.134]

Current State Analysis:
The Green Mountain Elementary School's Action Planning Team met to review the assessment results and use them to answer the question "What is the current state of our science program?" The team was concerned with the high number of students that were not meeting the standard in science. Scale score data indicated that physical science and inquiry were two possible areas to further explore. A large number of students performed low on the performance task investigation, providing additional evidence that inquiry might be an area of concern for the science program. Concept recommendations also pointed towards inquiry and physical science as areas for further investigation. In addition to the score report data, opportunity to learn data indicated that students were not consistently engaged in inquiry-based science programs throughout their Pre-K to 4 experience. Teacher surveys indicated that there was a significant lack of science content background among the staff, particularly in the areas of chemistry and physics. Teachers also indicated that they would be interested in pursuing professional development opportunities that included extended learning opportunities in science content and pedagogy, mentoring, teacher leadership, and collaboration.

Action State:
Following the initial review of the data the following steps were taken, informed by the assessment feedback.

1. *A science program committee was established. This group included teachers, a school administrator, the school district's curriculum coordinator and a science resource specialist from outside the district. The group took a closer look at the school's science curriculum, instructional practices, and resources, guided by the Current State Analysis and the Guidelines for Improving Student Results. This work revealed additional information regarding the science program.*
   - *Although there appeared to be no discrepancy in performance or opportunities among groups (male-female, minorities, etc.) there was a discrepancy in classroom level*

opportunities because some teachers taught an inquiry-based science program and others did not.

- *A review of the local science curriculum in light of the score data, the Vermont-PASS Domain, and the Framework indicated that students were experiencing and revisiting important science concepts at appropriate levels in most areas with the exception of some physical science concepts.*
- *A review of resources indicated that although important earth science standards were included in the curriculum, teachers did not have adequate resources to teach those concepts. Lack of resources was also an identified problem in the area of physical science.*

2. *The science program committee recommended the following strategies to the action planning committee and through that group, to the school board and community.*
    - *An amount of funds will be budgeted to support science program development, resources, and professional development for teachers.*
    - *With the help of a science resource specialist and the support of the school system, teachers will use the VT Framework and the National Science Education Standards to "fill the gaps" in the local articulated science curriculum.*
    - *A representative from the VISMT Science Cooperative will be invited to the school to help teachers explore options for standards based instructional materials and professional development in the use of those materials.*
    - *With the support of the school system, teachers will direct the process of developing a local science assessment system that will help provide continuity within the science program and inform instruction and student performance at all grade levels.*
    - *Two teachers who have expressed an interest in pursuing long term professional growth in science and taking on a science leadership role in the school will receive support from the school system to participate in the three year Vermont Science Initiative for elementary teachers.*

Desired State:
All parties involved in the Green Mountain Elementary School science improvement effort realize that it will take a number of years to achieve the ultimate goal of having all students meet the standard in science. However, yearly progress toward that goal and the relative success of the strategies employed will be measured by future administrations of the Vermont-PASS assessment in conjunction with local science assessment data.

Guidelines for Improving Student Results

The following are suggestions for possible actions to take to improve student performance on the Vermont-PASS science assessment.

If a large percentage of students are below the standard on the Vermont-PASS Science Assessment, you might want to consider the following actions:

- Determine if these results are consistent with classroom and school science assessment data and teacher perceptions.
- Develop an articulated K-12 science curriculum if none exists.
- Seek curriculum expertise in science or help in developing one.
- Look for developmentally appropriate standards-based science resources (i.e. textbooks, standards-based units, supporting materials, supplies, library and technology resources, community sources).
- Ask if the resources support inquiry in science.
- Make sure every teacher K-6 teaches science.
- Make sure every student K-12 has the opportunity to take science courses that address the full range of standards.
- Make sure every teacher K-12 has the content expertise to deliver the standards.
- Make sure every teacher integrates the Learning Opportunities ("best practice" pedagogy) into classroom instruction.
- Make sure standards-based assessments are used in every classroom for frequent student feedback and for making instructional decisions along the way.
- Allocate professional development resources to support improved science knowledge and pedagogy.
- Consider the full range of professional development models from large informational conferences to on-site demonstration of content and pedagogy and make sure **all** teachers have access to the professional development in science.

If your results show a large percentage of students in the "achieved the standard" and "honors' categories, but there are still students in the "below" or "little evidence" categories, you may want to consider:

- Disaggregating your data to see who the students in the below the standard categories are. (Are they female, minority, LEP, lower SFS, etc.?)
- Check course taking patterns to see if ALL students have the opportunity to access the full range of standards K-12 What courses have they taken? What opportunities have those courses offered?
- Collect any other data that will help determine what is in the way of their achievement? How do they differ from the groups nearly, meeting, and achieving honors?

If your results show an average percentage of students in the "achieved the standard" and "honors" categories, but more than half are only nearly or below meeting the standard, you may want to consider asking:

- Is our science program of a high quality, offering access of the full range of the standards to all students?
- Are ALL teachers equipped with the content and the pedagogy to not just "cover" the standards, but to enable students to master them?
- Who are the students in the "nearly" category? What courses have they taken? Have they had the same curriculum and opportunities as those meeting the standard?
- How do our results compare to other schools like us? If their results are different, how does their science program differ from ours?

Linking Vermont-PASS to Local Science Teaching and Assessment Through the Vermont-PASS Performance Task Template

The process of scientific inquiry can take on many forms with multiple entry points, strategies and directions pursued. However, there are certain reasoning and problem solving skills, concepts, and conventions that are fundamental to scientific literacy in this area. The Performance Task Template includes the components of inquiry used by the test development team (teachers and scientists) to develop tasks for the Vermont-PASS Assessment. As a large scale standardized assessment, Vermont-PASS performance tasks are limited in ways that school level teaching and assessment are not. The purpose of the Vermont-PASS Performance Task Template is to identify those important skills, concepts, and conventions of inquiry that are common to both PASS and school based teaching and assessment.

Objectives of Investigation/Performance Tasks:

1. To replicate an experiment.
2. To collect and organize data and information.
3. To use scientific equipment and information.
4. To use evidence to support or refute a prediction.
5. To demonstrate understanding of scientific concepts resulting from the experiment.
6. To use data/observations to apply, generalize or ask other questions based upon findings within a context.

VT-Framework Standards 7.1, 7.2

NSES: Science as Inquiry Content Standard A

Begin with the Standards

Vermont Framework Science Standards:
(Inquiry, Living World - Space, Time, Matter - Universe, Earth, Environment)
Criteria For Assessment From NSES:
(Inquiry, Life, Physical, Earth/Space Science)

1. Scenario:

Vermont-PASS: A scenario is used to describe a problem or invite students to engage in the inquiry. The scenario, in addition to students' prior knowledge and experiences provides evidence for a hypothesis that they will be asked to construct.

Local Summative Assessment: The scenario can be linked directly to the context used at the instructional level in the classroom. For instance, students who have been studying biodiversity of a river ecosystem might be presented with a problem or question related to the ecology of the river.

Ongoing Classroom Teaching and Assessment: As a classroom experiment, this "Invitation To Investigate" might come from an exploration in which the students have engaged, questions stemming from prior research or discussion, or brainstorming lists such as KWL. As facilitator, the teacher encourages students to generate their own ideas for inquiry while focusing the class on areas that will explore targeted science concept standards.

2. Problem Statement:

Vermont-PASS: Provides students with a testable question to investigate.

Local Summative Assessment: External standardized assessments such as PASS are limited by the time and equipment constraints associated with large-scale assessment. On the other hand, local assessments have more flexibility. Schools and teachers might choose to incorporate extended investigations that require more time and access to specialized equipment that the school can provide. A local assessment may also focus on one or several aspects of inquiry rather than all components included in this template. These considerations may affect the scope and parameters of a question or problem chosen for investigation at the local level compared to the state level.

Ongoing Classroom Teaching and Assessment: As a classroom experiment, teachers would help students formulate testable questions that they could go on to investigate individually, in groups, or as a class.

3. Prediction or Hypothesis:

Vermont-PASS: Requires students to provide a prediction based on a testable question. Students are prompted regarding any cause and effect relationships (e.g., make a prediction about the effect of temperature on the amount of gas dissolved in water). They are also asked to explain their reasoning.

Local Summative Assessment: Same

Ongoing Classroom Teaching and Assessment: As a classroom experiment, students would not be provided with a cause/effect prompt. The teacher would provide facilitation/instruction to help students develop a cause and effect hypothesis based on evidence, prior knowledge, experience, or research.

4. Experiment:

Vermont-PASS: Provides the experiment for the students to replicate.

Specifications/considerations:

- Most students can complete the experiment in 50 minutes.
- The experiment should require students to measure (time, temperature, linear measurement, mass, etc.).
- The experiment must require students to work with materials.
- If the analysis of results requires students to compare or find patterns in quantitative data, the experiment must include multiple trials or the collection of multiple data points.
- Results need to be reproducible (variables controlled).
- The context of the experiment must include true science concepts.

Local Summative Assessment: As a local assessment, schools might want to assess a student's ability to develop a procedure for testing a hypothesis. If a student's procedure does not adequately control variables or allow for the collection of sufficient and appropriate evidence, the student will be limited in his or her ability to demonstrate skills and understanding throughout the rest of the task. At the local level, this drawback can be overcome by assessing a student's performance again at a later time, following instruction related to experimental design. On the Vermont-PASS assessment, students are given the procedure so that they can collect valid data for analysis.

Ongoing Classroom Teaching and Assessment: As a classroom experiment, students would develop their own procedure for testing their hypothesis. Again, teacher facilitation/instruction would guide students as they consider variables to control, number of trials, necessary equipment and materials, and the type of evidence they need to collect.

5. Data collection and organization:

Vermont-PASS:

5th Grade

- Does not provide table, but explicitly states what needs to be in the table (e.g., make a table that includes the following….).
- Provides a title for the table.
- If the nature of the fifth grade investigation requires students to analyze observations rather than compare numerical data, a chart or diagram might be substituted for the table.

9th and 11th Grades

- Situation 1: Provides a table in which students will collect the data if the expectation is to represent the data graphically.
- Situation 2: If students are not expected to graph the data, then students will be required to create their own data tables. A title will be provided and then a statement will follow that says: Create, Organize and clearly Label a table. Your table should include all trials and variables tested or observations made."

Specifications for graphs:

- Titles of graphs are to be provided (e.g., the effect of temperature on the amount of dissolved gas in water).
- Axis provided but no labels on the axis.

Local Summative Assessment: In local assessments, data representation guidelines can be tailored to local curriculum, student self-assessment guides or rubrics as well as other locally developed performance standards for data organization and representation.

Ongoing Classroom Teaching and Assessment: As a classroom experiment, teachers can encourage students to record and organize evidence using a wide range of appropriate data representation. Teachers can help students decide on what observations to include, what type of data representation to use, and how to organize the data. Teachers can also purposefully integrate data representation and statistical analysis concepts from the students' mathematics program. At upper levels, extended classroom investigations will allow teachers and students to incorporate more sophisticated data analysis tools such as spreadsheets, scatter plots, and image processing.

6. Conduct the experiment:

Vermont-PASS: Students follow the procedure and collect data in the table.

Local Summative Assessment: On the local level, teachers might choose to have students work as collaborative teams to collect data and then analyze the data independently for the purpose of individual assessment.

Ongoing Classroom Teaching and Assessment: As a classroom experiment, students can collect evidence over an extended period of time. Changes to experimental procedures can be incorporated as needed.

7. Use of evidence:

Vermont-PASS: Students will use the evidence to support or refute their predictions, analyze and interpret data and draw conclusions.

Local Summative Assessment: Same
Vermont-PASS attempts to make a strong link between the analysis and interpretation of data on the assessment and the performance of those skills within school and classroom science programs.

Ongoing Classroom Teaching and Assessment: Same

8. Analysis - Interpretation - Synthesis - Application of findings:

Vermont-PASS:

Specifications: Selects one of the following for each performance task depending upon the opportunity in the task.

- Generate an alternative explanation or hypothesis based upon observations and evidence collected.
- Generate new questions. (Used only if the experiment causes disequalibrium.) For instance, the data collected might be conflicting or show no clear pattern. In that case, the student could be asked to think of a new question that could be investigated in order to obtain a clearer analysis.
- Apply findings to the original scenario or similar situation (application).
- Generalize findings or express limitations of findings in making a generalization.

Local Summative Assessment: Same

Ongoing Classroom Teaching and Assessment: As a classroom experiment, teachers and students can take the "next step" by continuing experimentation and research related to the investigation or taking action based on the results of the investigation.

How to Use the Vermont-PASS Performance Task Template

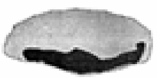
Linking School-based Science Programs with the Vermont-PASS Statewide Science Assessment

Vermont-PASS:
Vermont-PASS uses task specific, analytic scoring guides based on the content and developmental levels recommended by the Vermont Framework and National Science Education Standards. Extensive scoring procedures provide high inter-rater reliability. Feedback from the performance task and the rest of the assessment reflects the degree to which a school's science program is helping all students reach science literacy

Vermont-PASS Performance Task Template

Jean's mother asked her to clean out the barn. While doing so she found a pile of unusual round clumps that looked liked they could have come from some kind of animal. She recalled hearing an owl in this area a few nights ago. She remembered learning in school that owls eat small animals, swallow their food whole and spit out what they don't digest. These clumps are called owl pellets. Jean wondered (hypothesized) if the clumps she found in the barn could be owl pellets. As a fifth grade scientist, you will help Jean support or reject her hypothesis by investigating the unusual round clumps.

Unusual round clump



Local Summative Science Assessment:
Many schools are developing end of the unit/course science assessments. In additional to written evidence, local assessments might also include presentations, products, and models as well as other indicators. This flexibility can accomodate a variety of learning styles and provide useful individual student performance data.

Using the Template to Design Local Assessment Performance Tasks

The content standards for this task deals with interactions (specifically food and energy) of organisms in an ecosystem and categorizing living organisms. As a local summative assessment for students who have completed a unit on ecosystems, the investigation might focus on specific concepts, questions and problems raised during the course of the unit. The task might also include an application to a local environment.

Classroom Teaching and Assessment:
Classroom rteachers continuously collect assessment feedback from a variety of sources such as discussion, student journals, lab reports, student products and presentations, tests, videotaping, etc. Students also monitor individual and peer progress using self-assessment scoring guides and rubrics. At the classroom level, statistical reliability for a single assessment might be low. However, when a student is given a variety of ways to demonstrate skills and understanding, these multiple measures in conjunction with local assessment data can provide and accurate and informative student profile for science.

Using the Template to Design Classroom Investigations and Assessments

In the context of classroom teaching and assessment, an investigation of owl pellets might become a part of a unit exploring a larger theme. For example, in the Insights unit "Bones and Skeletons," students investigate the bones in owl pellets as an experience leading to a greater understanding of skeletal systems in vertebrates. In another classroom, the dissection of owl pellets might be part of an extended inquiry involving predator-prey relationships.